

U.S. Patent Application Serial No. 09/939,716  
Amendment filed December 16, 2005  
Reply to OA dated July 25, 2005

**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

**Listing of Claims:**

1           Claim 1 (original): An optical transmitter comprising;  
2           an input terminal for accepting an electrical binary signal,  
3           bandwidth restriction means for restricting bandwidth of said electrical binary signal,  
4           an electrical-optical conversion means for converting said electrical signal which is  
5           bandwidth restricted by said bandwidth restriction means to an optical signal,  
6           an amplifier for amplifying an input signal of said electrical-optical conversion means so that  
7           said input signal has enough level for operating said electrical-optical conversion means,  
8           wherein said bandwidth restriction means locates between an output of said amplifier and  
9           an input of said electrical-optical conversion means.

1           Claim 2 (original): An optical transmitter according to claim 1, wherein  
2           a precoding means is provided at an input stage of said amplifier,  
3           said precoding means provides a binary output which is the same as the previous output when  
4           an input binary digital signal is 0, and an output which differs from the previous output when an

5 input digital signal is 1, and

6 said bandwidth restriction means is a low-pass filter which generates a ternary duobinary  
7 signal.

1 Claim 3 (original): An optical transmitter according to claim 2, wherein said electrical-  
2 optical conversion means provides the maximum level of optical output for an input electrical signal  
3 having the maximum level and the minimum level, the minimum level of optical output for an input  
4 electrical signal having middle level between said maximum level and said minimum level, and  
5 optical phase of said maximum level of said optical signal is opposite of optical phase of said  
6 minimum level of said optical signal.

1 Claim 4 (original): An optical transmitter according to claim 3, wherein said electrical-  
2 optical conversion means is a Mach Zehnder light intensity modulator having a pair of electrodes  
3 which are driven by ternary electrical duobinary signals having opposite polarities.

1 Claim 5 (original): An optical transmitter according to claim 1, wherein at least two of said  
2 bandwidth restriction means, said electrical-optical conversion means, and said amplifier are  
3 integrated in a single module.

1           Claim 6 (original): An optical transmitter according to claim 5, wherein said electrical-  
2           optical conversion means has function as said bandwidth restriction means.

1           Claim 7 (original): An optical transmitter comprising;  
2           an input terminal for accepting an electrical binary signal,  
3           an electrical-optical conversion means for converting an electrical signal to an optical signal,  
4           an amplifier for amplifying an input signal applied to said input terminal to level requested  
5           for operating said electrical-optical conversion means, and applying the amplified electrical signal  
6           to said electrical-optical conversion means,  
7           said electrical-optical conversion means having a travelling wave type electrode operating  
8           to restrict bandwidth of an output light of said electrical-optical conversion means.

1           Claim 8 (original): An optical transmitter according to claim 6 or claim 7, wherein said  
2           electrical-optical conversion means is a Mach Zehnder light intensity modulator having a travelling  
3           wave type electrode, and bandwidth of optical output of said Mach Zehnder light intensity modulator  
4           is restricted by using loss of said travelling wave type electrode.

1           Claim 9 (original): An optical transmitter according to claim 6 or claim 7, wherein said  
2           electrical-optical conversion means is a Mach Zehnder light intensity modulator having a travelling  
3           wave type electrode, and bandwidth of optical output of said Mach Zehnder light intensity modulator

4 is restricted by using mismatching of phase velocity of electric wave propagating said travelling  
5 wave type electrode and optical wave propagating in an optical waveguide having refractive index  
6 depending upon electrical field generated by said electric wave.

1 Claim 10 (previously presented): An optical transmitter according to claim 8, wherein;  
2 a precoding means is provided at an input stage of said amplifier,  
3 said precoding means provides an output which is the same as the previous output when an  
4 input binary digital signal is 0, and an output which differs from the previous output when an input  
5 digital signal is 1, and  
6 said travelling wave type electrode is designed so that phase change of optical wave  
7 propagating in said optical waveguide depending upon said electrical field has waveforms of a  
8 ternary duobinary signal.

1 Claim 11 (original): An optical transmitter according to claim 10, wherein said electrical-  
2 optical conversion means provides the maximum level of optical output for an input electrical signal  
3 having the maximum level and the minimum level, the minimum level of optical output for an input  
4 electrical signal having middle level between said maximum level and said minimum level, and  
5 optical phase relating to said maximum level of said optical signal is opposite of optical phase  
6 relating to said minimum level of said optical signal.

1           Claim 12 (original):   An optical transmitter according to claim 11, wherein said electrical-  
2           optical conversion means is a Mach Zehnder light intensity modulator having a pair of electrodes,  
3           each of which is a travelling wave type electrode having bandwidth restriction property, and  
4           electrical signals applied to each electrodes are binary signals having opposite polarities with each  
5           other.

1           Claim 13 (currently amended):       An optical transmitter comprising;  
2           an input terminal for accepting an electrical binary signal,  
3           bandwidth restriction means for restricting bandwidth of said electrical binary signal,  
4           an electrical-optical conversion means for converting said electrical signal which is  
5           bandwidth restricted by said bandwidth restriction means to an optical signal,  
6           an amplifier for amplifying an input signal of said electrical-optical conversion means so that  
7           said input signal has enough level for operating said electrical-optical conversion means,  
8           wherein said bandwidth restriction means locates between an output of said amplifier and  
9           an input of said electrical-optical conversion means,  
10          wherein at least two of said bandwidth restriction means, said electrical-optical conversion  
11          means, and said amplifier are integrated in a single module,  
12          wherein said electrical-optical conversion means has function as said bandwidth restriction  
13          means,  
14          wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator

U.S. Patent Application Serial No. 09/939,716  
Amendment filed December 16, 2005  
Reply to OA dated July 25, 2005

15 having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light  
16 intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating  
17 said travelling wave type electrode and optical wave propagating in an optical waveguide having  
18 refractive index depending upon electrical field generated by said electric wave ~~An optical~~  
19 ~~transmitter according to claim 9,~~

20 wherein travelling direction of said electrical signal in said electrode is opposite to travelling  
21 direction of optical signal in said optical waveguide.

1 Claim 14 (original): An optical transmitter according to claim 9, wherein said Mach  
2 Zehnder light intensity modulator is provided on a substrate of Z-cut Lithium-Niobate.

1 Claim 15 (original): An optical transmitter according to claim 9, wherein said Mach  
2 Zehnder light intensity modulator is provided on a substrate of X-cut Lithium-Niobate.

1 Claim 16 (original): An optical transmitter according to claim 8, wherein loss in said  
2 travelling wave type electrode at  $f_0/2$  is always larger than loss at frequency higher than  $f_0/2$ , and  
3 modulation efficiency of said Mach Zehnder light intensity modulator at  $f_0/2$  is larger than that at  
4 frequency higher than  $f_0/2$ , where  $f_0$  is clock frequency of said electrical binary signal.

1           Claim 17 (currently amended):       An optical transmitter comprising;  
2           an input terminal for accepting an electrical binary signal,  
3           bandwidth restriction means for restricting bandwidth of said electrical binary signal,  
4           an electrical-optical conversion means for converting said electrical signal which is  
5           bandwidth restricted by said bandwidth restriction means to an optical signal,  
6           an amplifier for amplifying an input signal of said electrical-optical conversion means so that  
7           said input signal has enough level for operating said electrical-optical conversion means,  
8           wherein said bandwidth restriction means locates between an output of said amplifier and  
9           an input of said electrical-optical conversion means,  
10           wherein at least two of said bandwidth restriction means, said electrical-optical conversion  
11           means, and said amplifier are integrated in a single module,  
12           wherein said electrical-optical conversion means has function as said bandwidth restriction  
13           means,  
14           wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator  
15           having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light  
16           intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating  
17           said travelling wave type electrode and optical wave propagating in an optical waveguide having  
18           refractive index depending upon electrical field generated by said electric wave ~~An optical~~  
19           ~~transmitter according to claim 9,~~  
20           wherein modulation efficiency of said Mach Zehnder light intensity modulator at  $f_0/2$  is

always larger than that at frequency higher than  $f_0/2$ , where  $f_0$  is clock frequency of said electrical binary signal.

Claim 18 (currently amended):     An optical transmitter comprising;  
an input terminal for accepting an electrical binary signal,  
bandwidth restriction means for restricting bandwidth of said electrical binary signal,  
an electrical-optical conversion means for converting said electrical signal which is  
bandwidth restricted by said bandwidth restriction means to an optical signal,  
an amplifier for amplifying an input signal of said electrical-optical conversion means so that  
said input signal has enough level for operating said electrical-optical conversion means,  
wherein said bandwidth restriction means locates between an output of said amplifier and  
an input of said electrical-optical conversion means,  
wherein at least two of said bandwidth restriction means, said electrical-optical conversion  
means, and said amplifier are integrated in a single module,  
wherein said electrical-optical conversion means has function as said bandwidth restriction  
means,  
wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator  
having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light  
intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating  
said travelling wave type electrode and optical wave propagating in an optical waveguide having



18 ~~refractive index depending upon electrical field generated by said electric wave~~ ~~An optical~~  
19 ~~transmitter according to claim 9~~, wherein;

20 a precoding means is provided at an input stage of said amplifier,

21 said precoding means provides an output which is the same as the previous output when an  
22 input binary digital signal is 0, and an output which differs from the previous output when an input  
23 digital signal is 1, and

24 said travelling wave type electrode is designed so that phase change of optical wave  
25 propagating in said optical waveguide depending upon said electrical field has waveforms of a  
26 ternary duobinary signal.

1 Claim 19 (new): An optical transmitter comprising;  
2 an input terminal for accepting an electrical binary signal,  
3 an electrical-optical conversion means for converting an electrical signal to an optical signal,  
4 an amplifier for amplifying an input signal applied to said input terminal to level requested  
5 for operating said electrical-optical conversion means, and applying the amplified electrical signal  
6 to said electrical-optical conversion means,

7 said electrical-optical conversion means having a travelling wave type electrode operating  
8 to restrict bandwidth of an output light of said electrical-optical conversion means,

9 wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator  
10 having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light

intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating said travelling wave type electrode and optical wave propagating in an optical waveguide having refractive index depending upon electrical field generated by said electric wave,  
wherein travelling direction of said electrical signal in said electrode is opposite to travelling direction of optical signal in said optical waveguide.

Claim 20 (new): An optical transmitter comprising;  
an input terminal for accepting an electrical binary signal,  
an electrical-optical conversion means for converting an electrical signal to an optical signal,  
an amplifier for amplifying an input signal applied to said input terminal to level requested for operating said electrical-optical conversion means, and applying the amplified electrical signal to said electrical-optical conversion means,  
said electrical-optical conversion means having a travelling wave type electrode operating to restrict bandwidth of an output light of said electrical-optical conversion means,  
wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating said travelling wave type electrode and optical wave propagating in an optical waveguide having refractive index depending upon electrical field generated by said electric wave,  
wherein modulation efficiency of said Mach Zehnder light intensity modulator at  $f_0/2$  is

15 always larger than that at frequency higher than  $f_0/2$ , where  $f_0$  is clock frequency of said electrical  
16 binary signal.

1 Claim 21 (new): An optical transmitter comprising;  
2 an input terminal for accepting an electrical binary signal,  
3 an electrical-optical conversion means for converting an electrical signal to an optical signal,  
4 an amplifier for amplifying an input signal applied to said input terminal to level requested  
5 for operating said electrical-optical conversion means, and applying the amplified electrical signal  
6 to said electrical-optical conversion means,  
7 said electrical-optical conversion means having a travelling wave type electrode operating  
8 to restrict bandwidth of an output light of said electrical-optical conversion means,  
9 wherein said electrical-optical conversion means is a Mach Zehnder light intensity modulator  
10 having a travelling wave type electrode, and bandwidth of optical output of said Mach Zehnder light  
11 intensity modulator is restricted by using mismatching of phase velocity of electric wave propagating  
12 said travelling wave type electrode and optical wave propagating in an optical waveguide having  
13 refractive index depending upon electrical field generated by said electric wave, wherein;  
14 a precoding means is provided at an input stage of said amplifier,  
15 said precoding means provides an output which is the same as the previous output when an  
16 input binary digital signal is 0, and an output which differs from the previous output when an input  
17 digital signal is 1, and

U.S. Patent Application Serial No. **09/939,716**  
Amendment filed December 16, 2005  
Reply to OA dated July 25, 2005

18           said travelling wave type electrode is designed so that phase change of optical wave  
19   propagating in said optical waveguide depending upon said electrical field has waveforms of a  
20   ternary duobinary signal.

\*       \*       \*       \*